

Indicators of Climate Change in California

Climate Change Conference 2009

September 9

Sacramento, CA

by
Linda Mazur

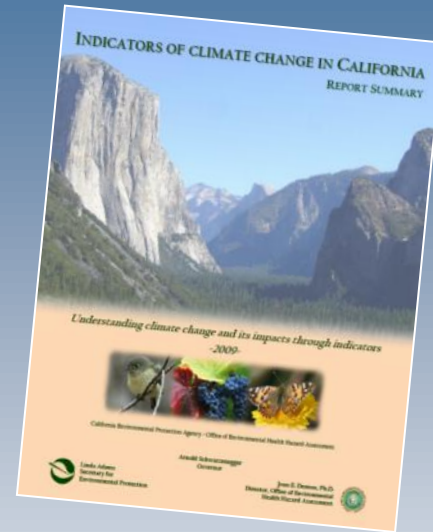
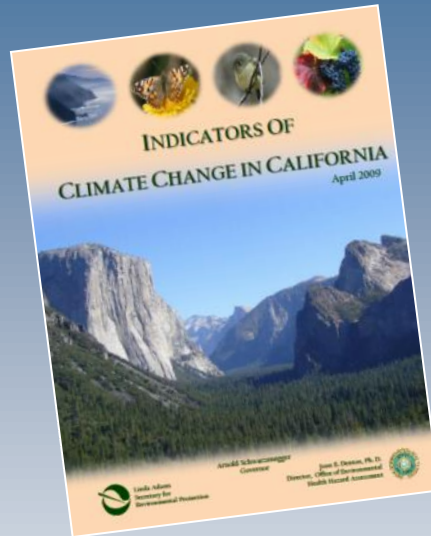


Office of Environmental Health Hazard Assessment
California Environmental Protection Agency





California's climate change story



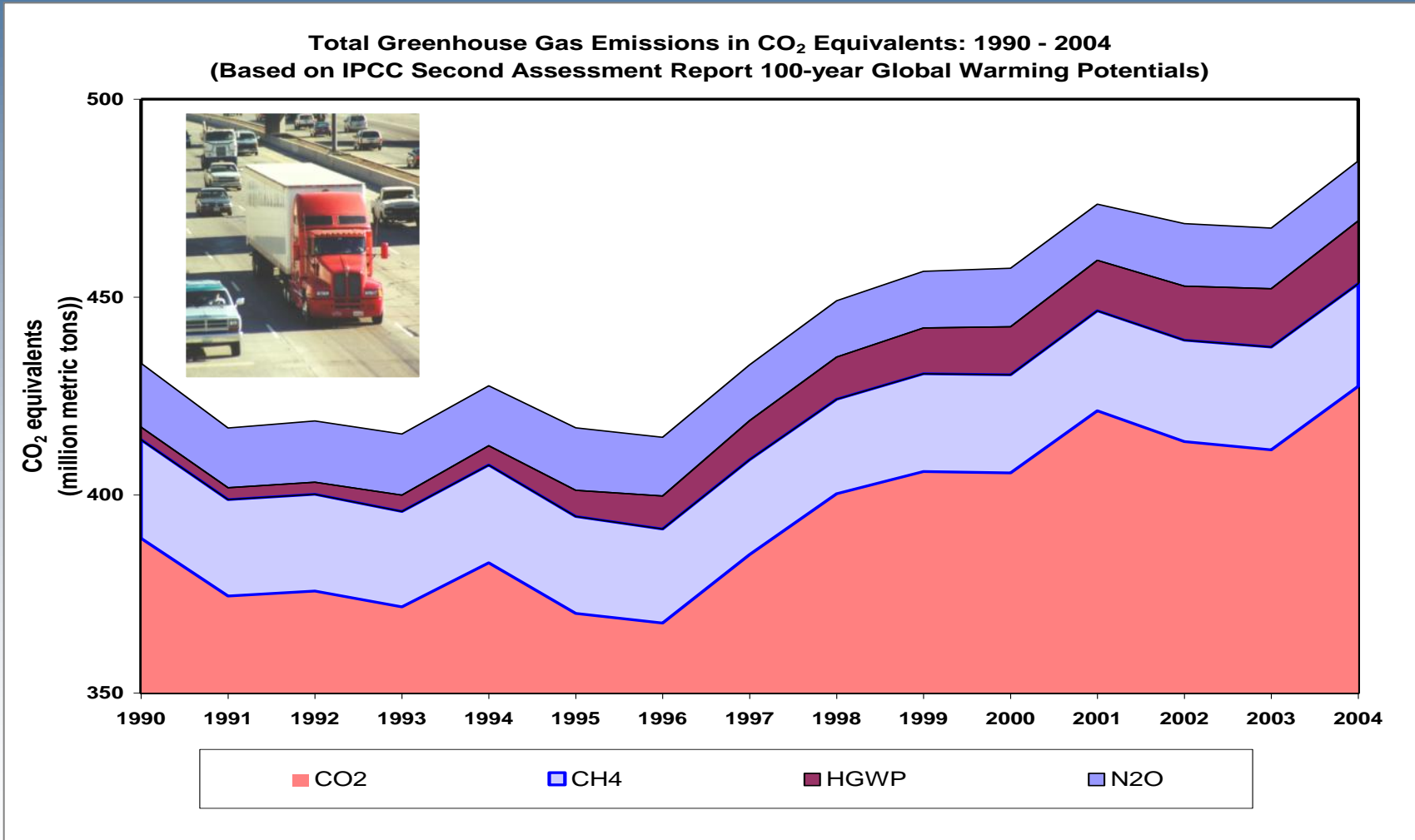
- In collaboration with CalEPA, the California Energy Commission, state and federal agencies and universities and research institutions



Purpose

- To provide an overview of the indicator report and summarize the indicators
- To examine the indicator relationships and present the trends and status of climate change in California based on observational data

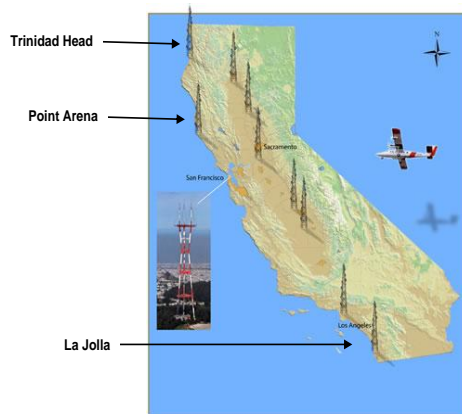
Greenhouse gas emissions have increased



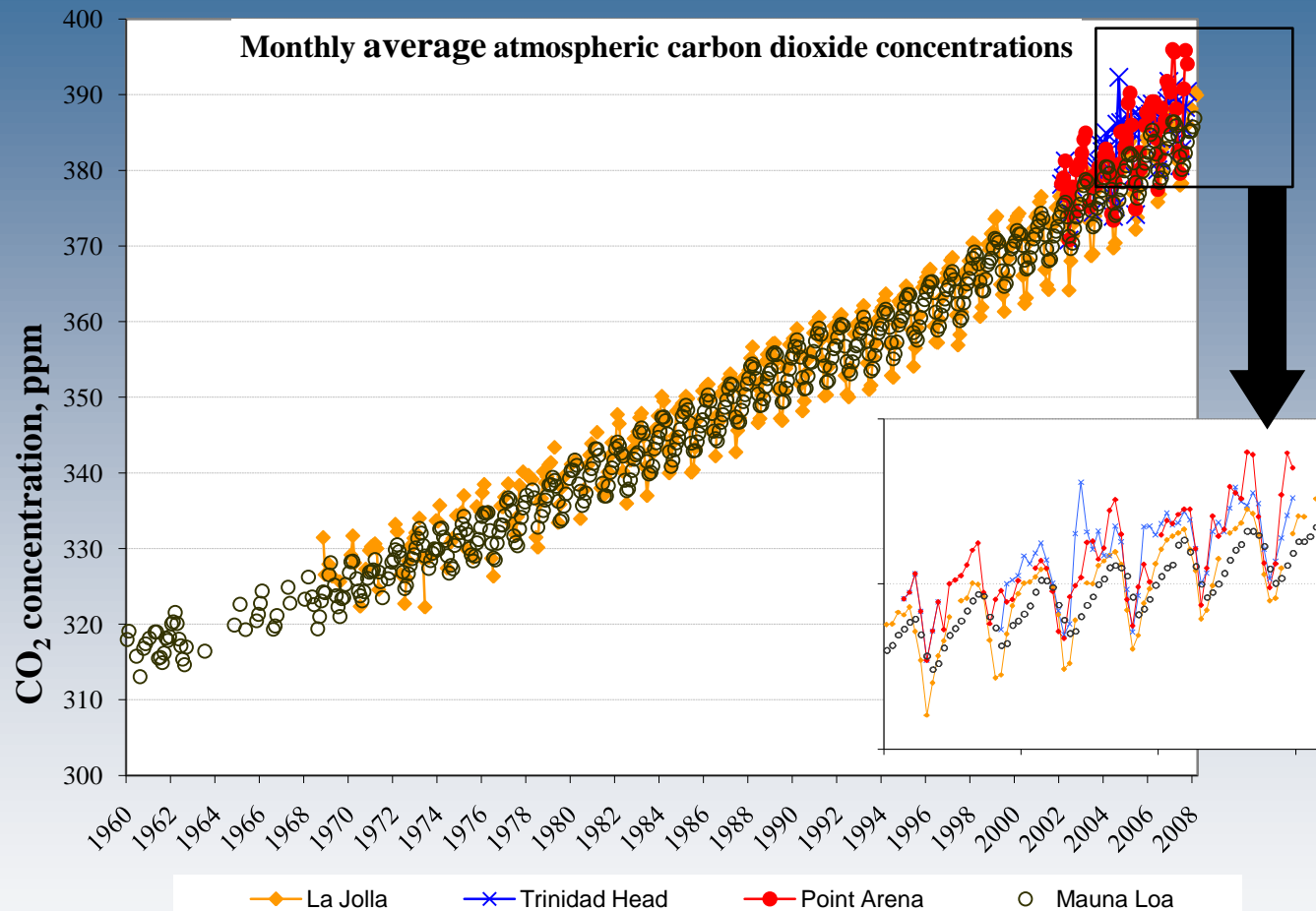
Source: Karen Lutter, Air Resources Board 2008

...as have ambient CO₂ levels

California carbon dioxide monitoring locations

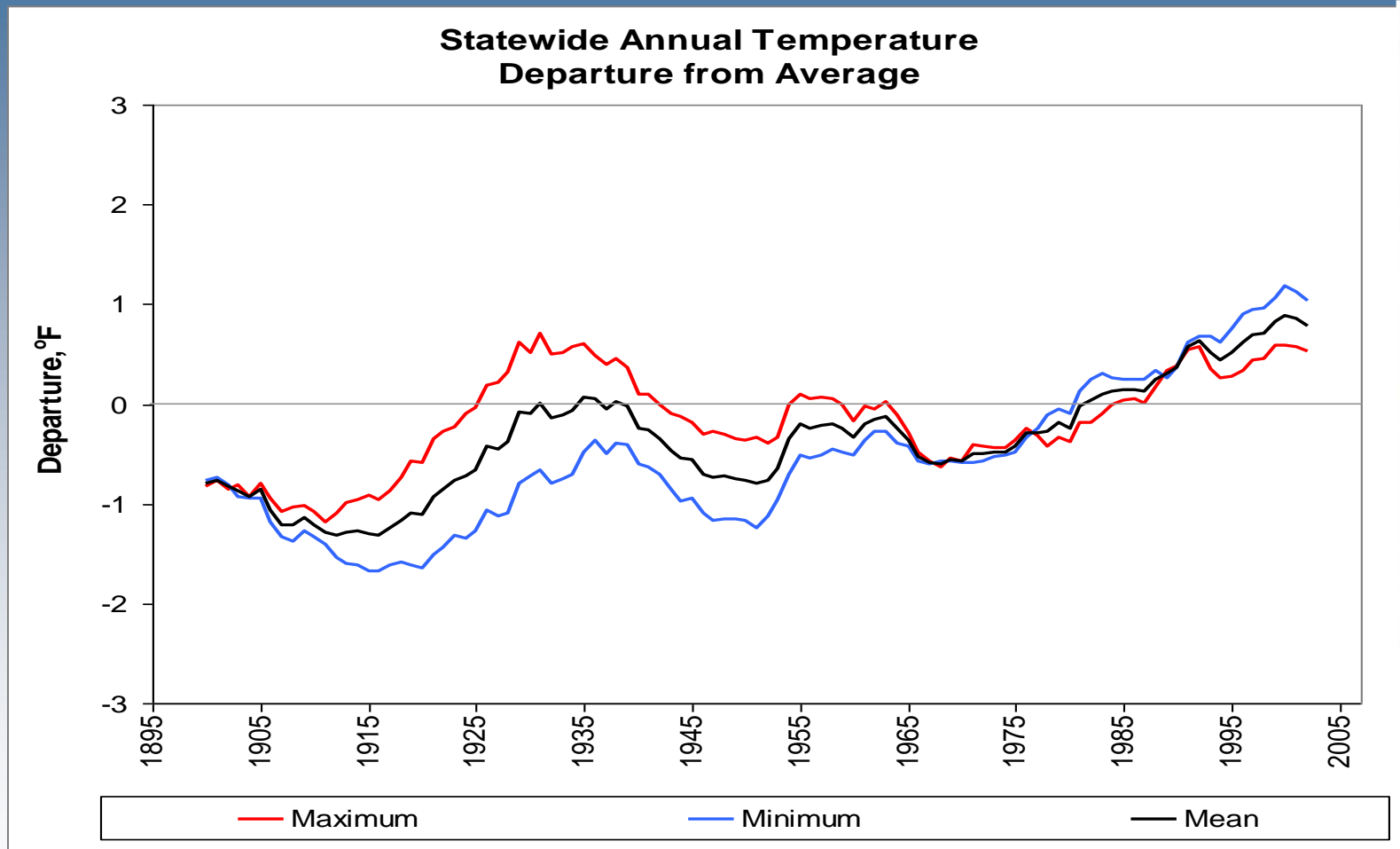


Source: Lawrence Berkeley Laboratory, 2007



Source: Marc Fischer, Lawrence Berkeley National Laboratory 2008

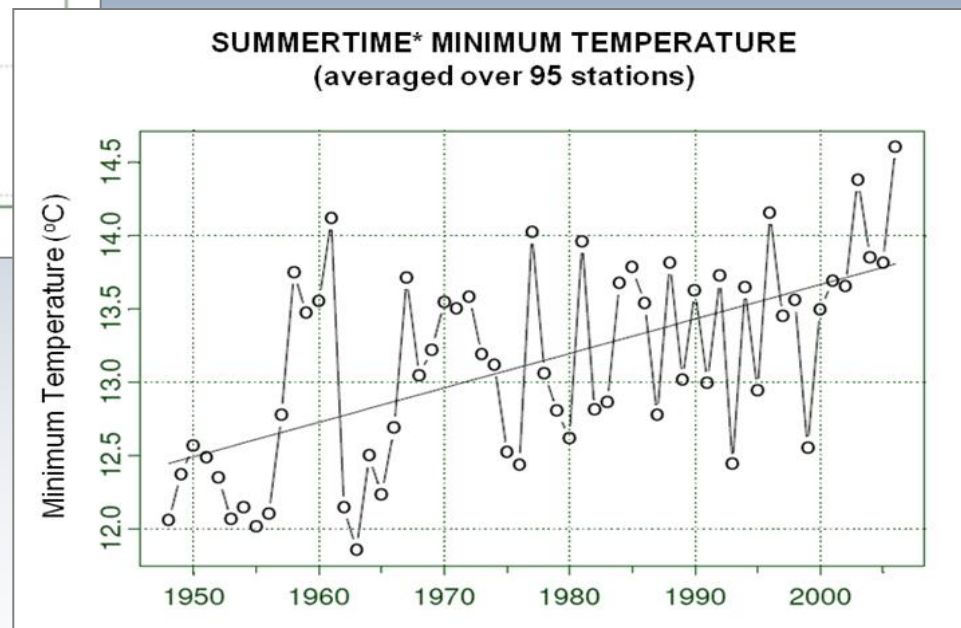
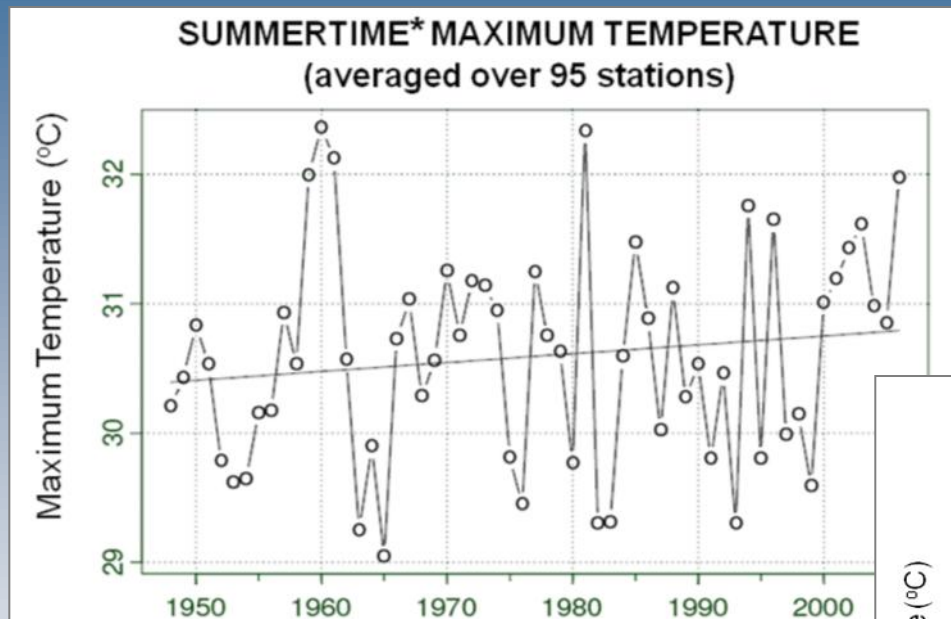
California's temperatures have increased, with minimum temperatures rising faster



Source: Laura Edwards, John Abatzoglou Desert Research Institute, 2008

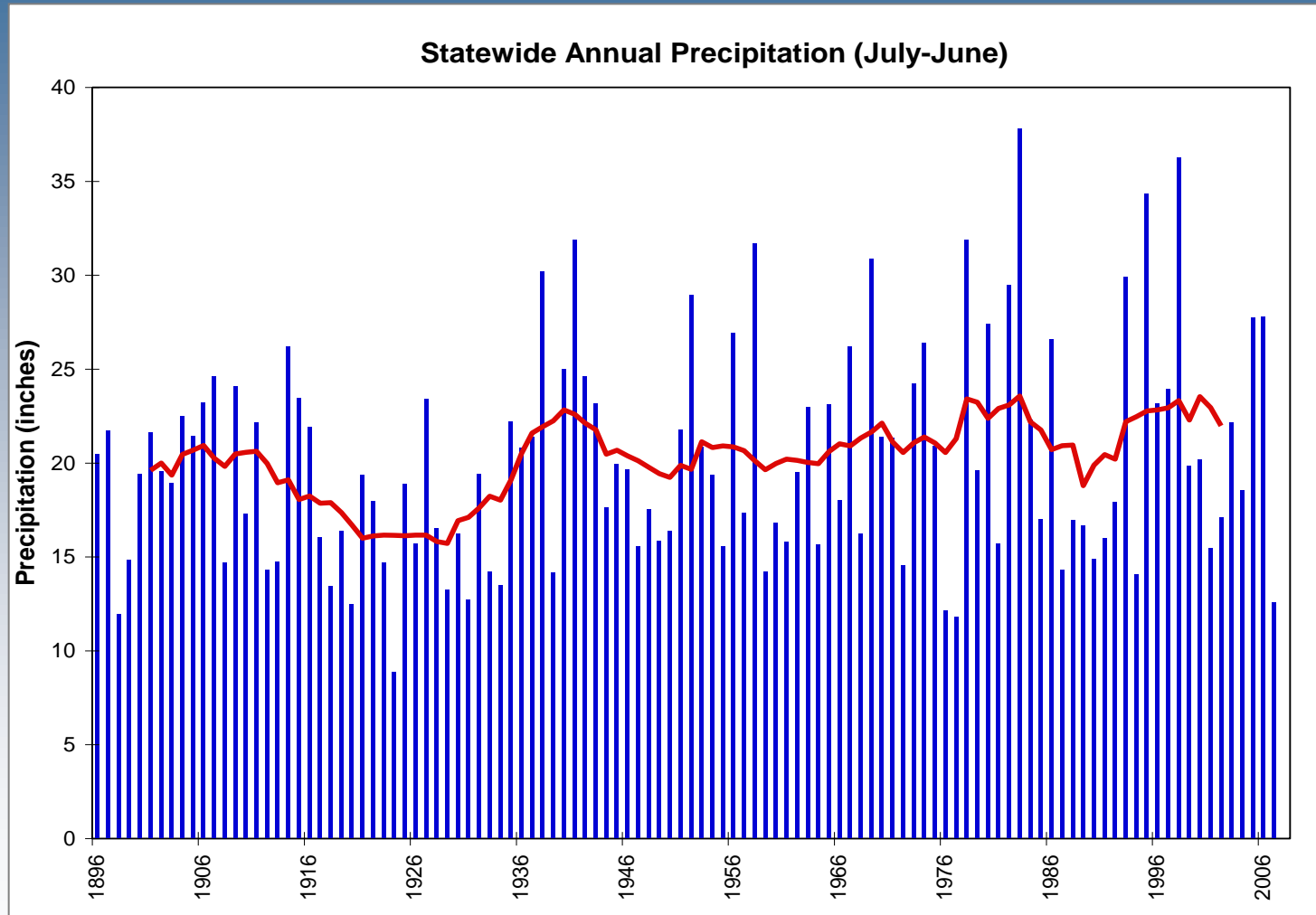
California's extreme heat temperatures have increased

...with nighttime temps rising faster



Source: NCDC, 2007 (data); Gershunov, 2008 (analysis)

Annual precipitation has stayed the same

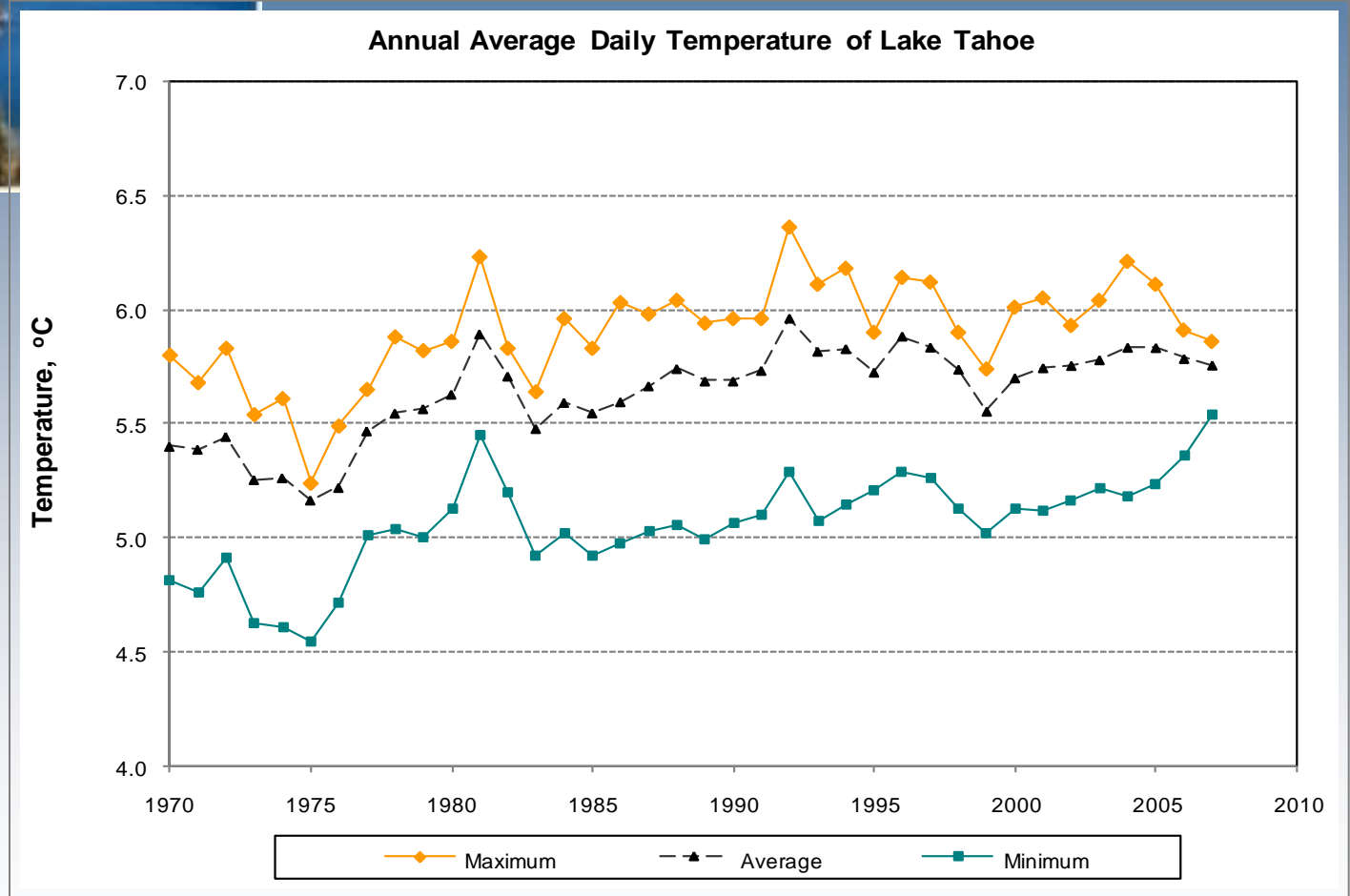
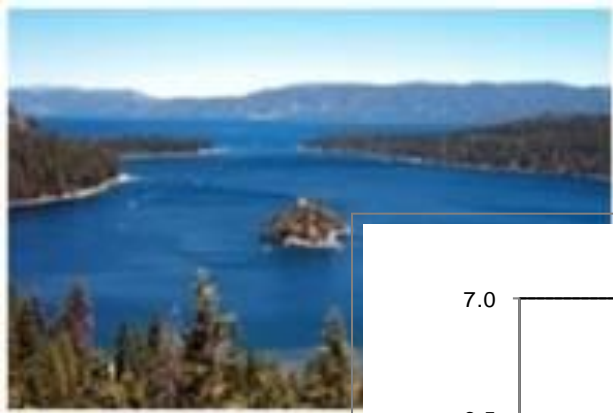


Source: Laura Edwards , John Abatzoglou, Desert Research Institute 2008

Climate Change: Sierra Nevada



Lake Tahoe's waters are warming



Source: Robert Coats, UC Davis TERC 2008

Sierra Nevada glaciers have decreased in size

Lyell Glacier



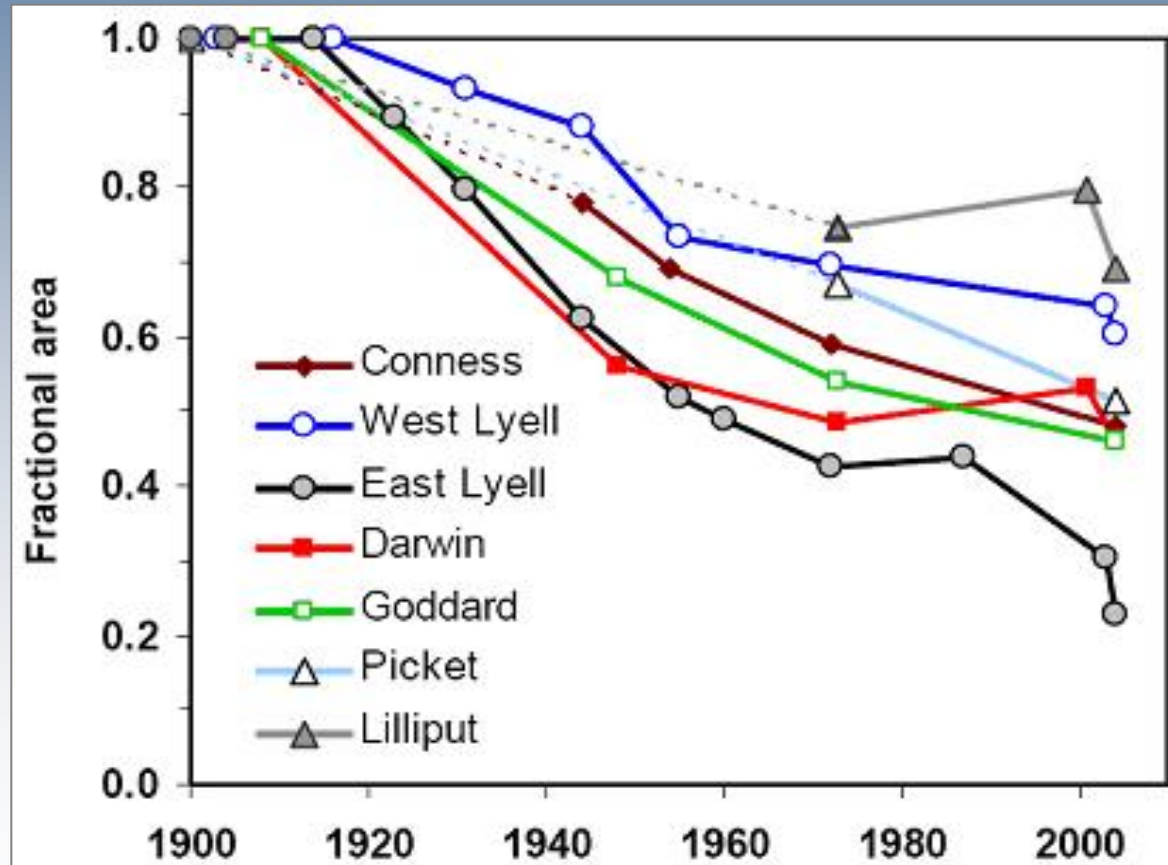
1903

G. K. Gilbert



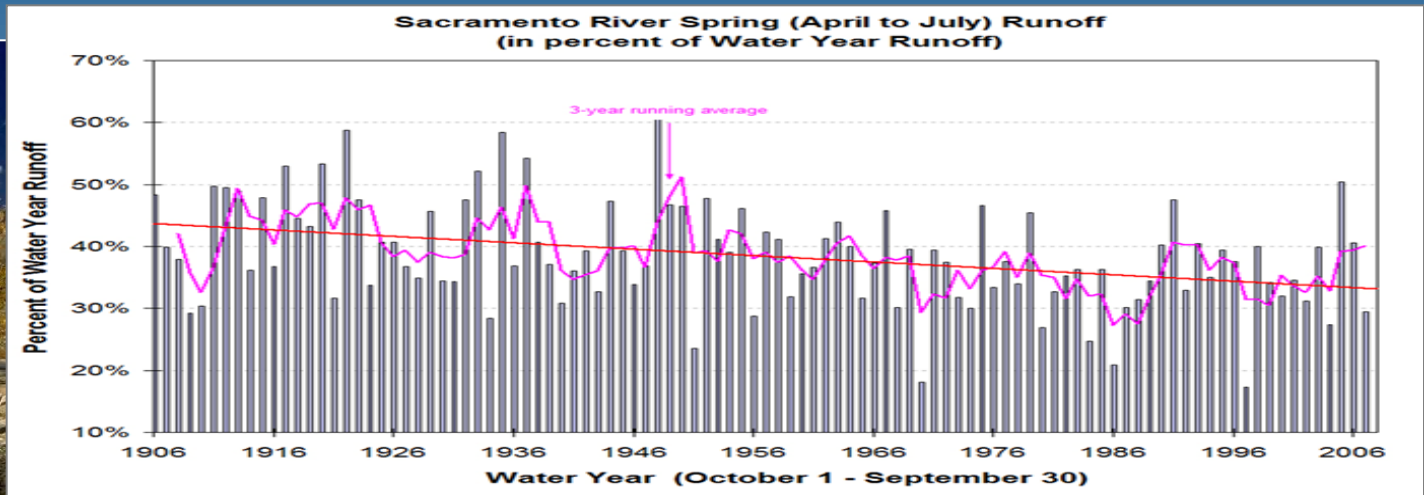
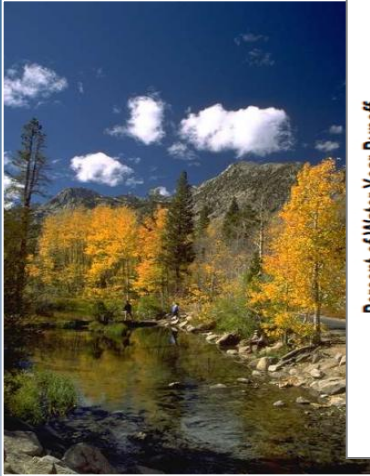
2004

H. Basagic



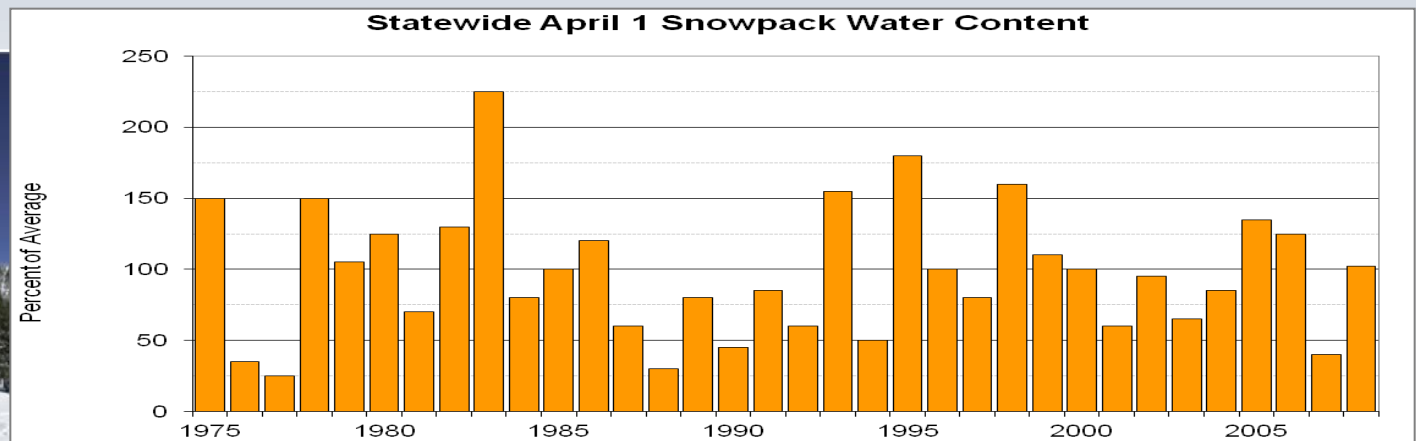
Source: Andrew Fountain, Hassan Basagic, Portland State University 2008

Spring snowmelt runoff has been declining



Source: Maurice Roos, Department of Water Resources 2008

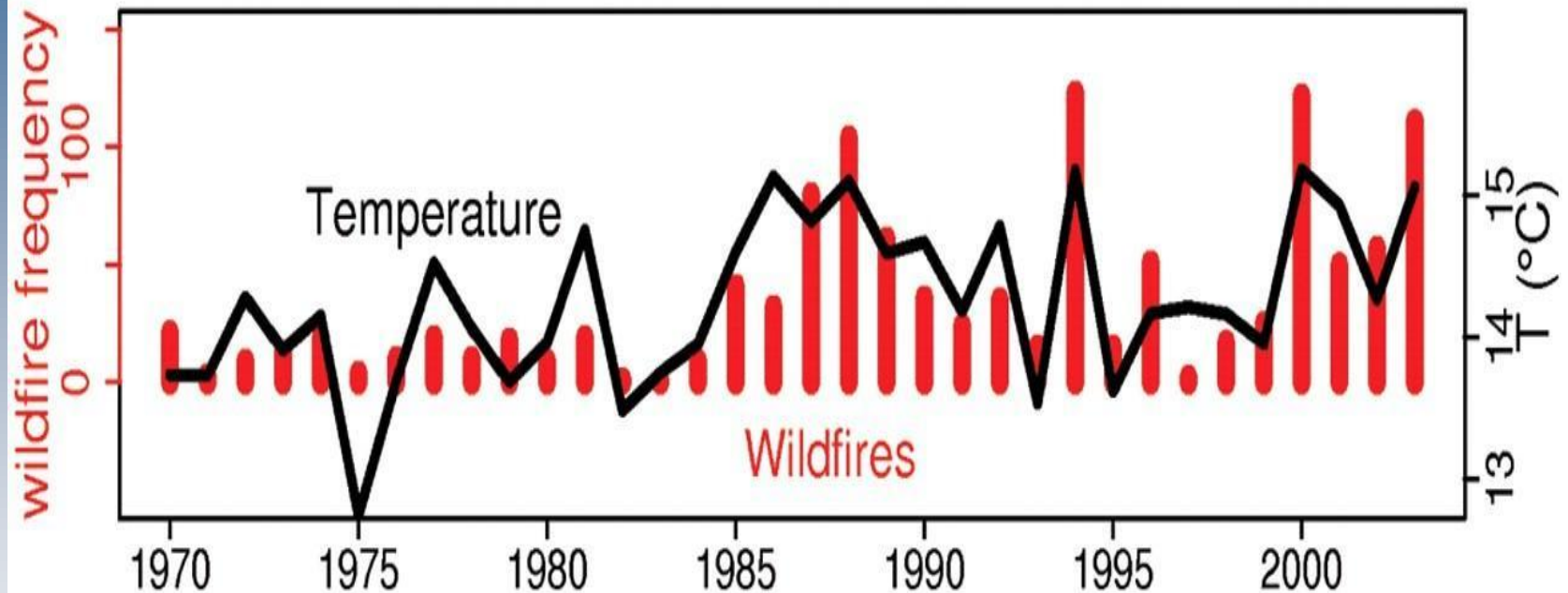
Snowpack water content has stayed the same



Source: Michael Dettinger, Scripps Institute of Oceanography 2008

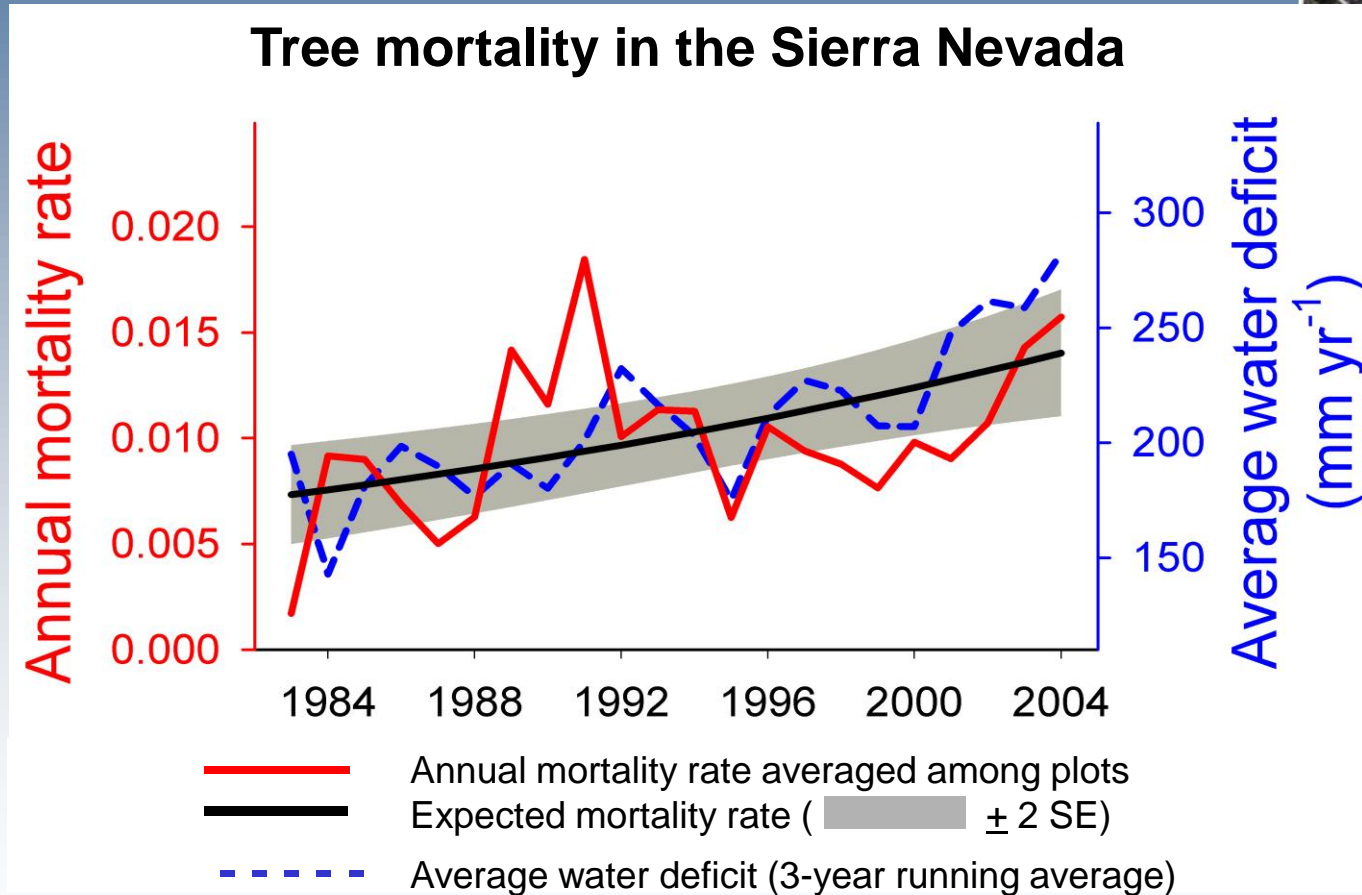
Large wildfires are becoming more frequent

Wildfire frequency and mean March-August temperature



Source: Tony Westerling, et al., University of California Merced 2007

Tree deaths in the Sierra Nevada have increased



Source: Phil van Mantgem and Stephenson, United States Geological Survey
2007

Certain plant and animal species are changing elevations

- Small mammal populations are found at different elevations today compared with earlier in the century.
Resurvey of the Grinnell study



Source: Moritz, University of California Berkeley 2008

- Alpine and subalpine plant changes are being tracked.

Global observation research initiative in alpine environments (GLORIA)



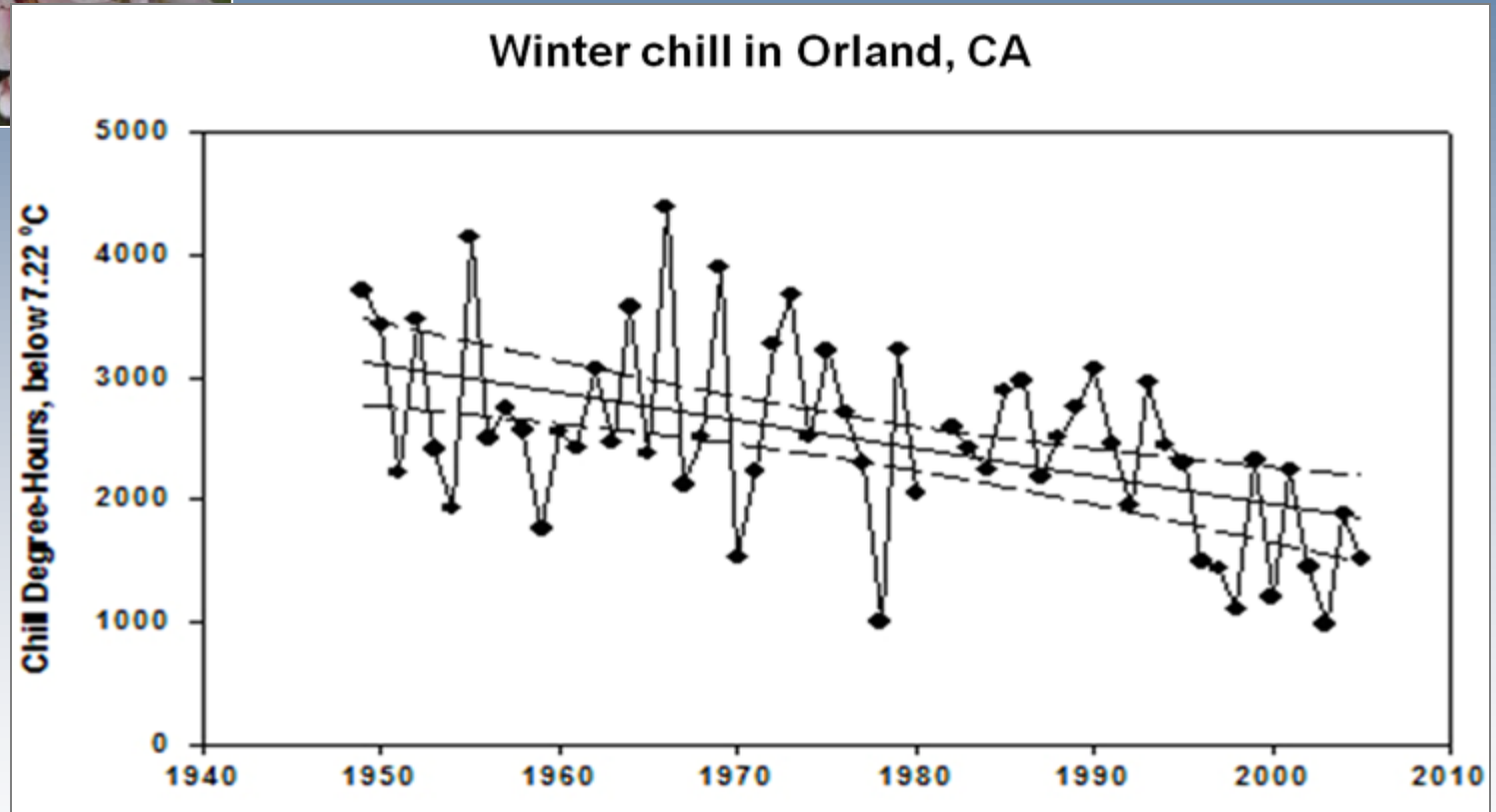
Source: Constance Millar, USDA Forest Service 2008

Climate Change: Central Valley





Chill hours have declined

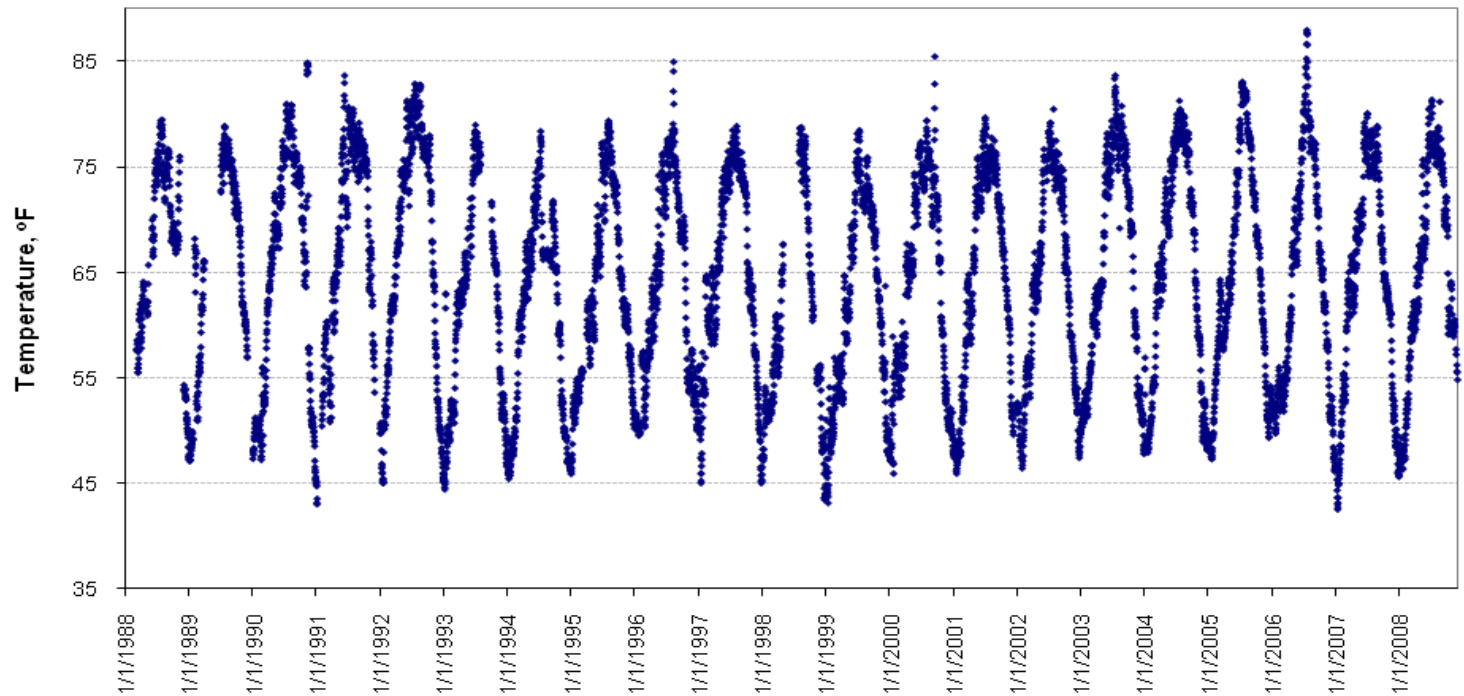


Source: Baldocchi and Wong 2007

Delta water temperature has stayed the same

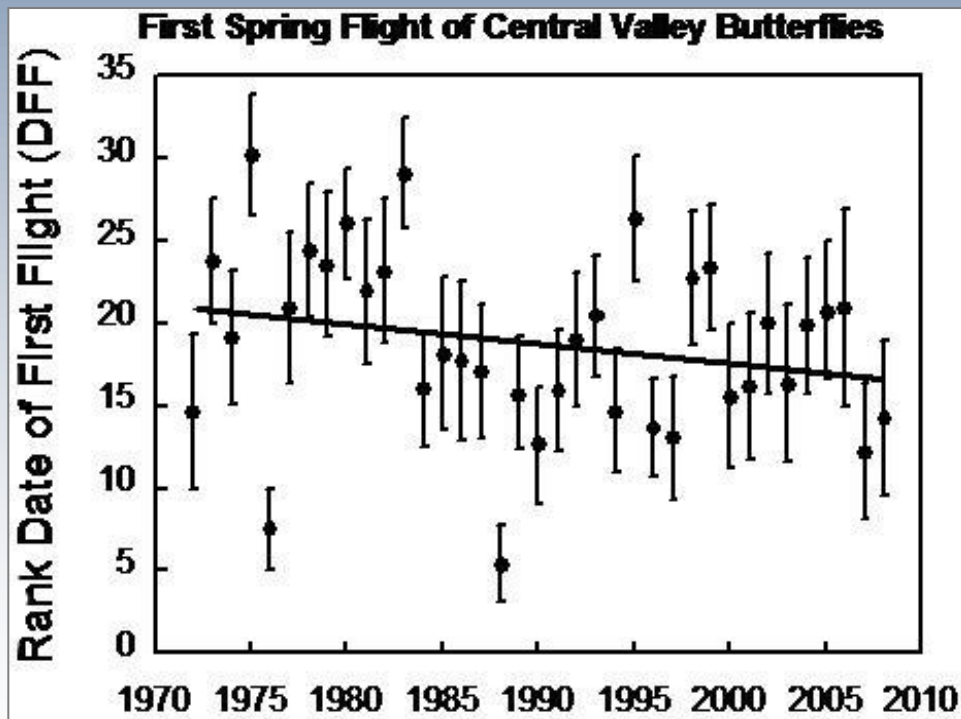


Daily Water Temperatures
(measured at the Clifton Court Station)

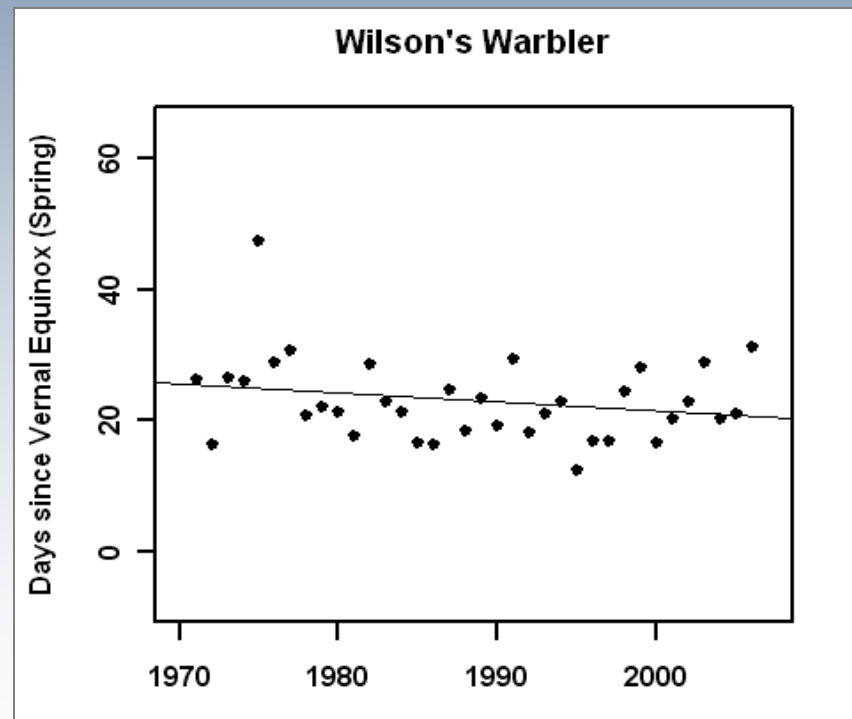


Source: Michael Dettinger (SIO)
based on data from Department of Water Resources 2008

Central Valley butterflies have been appearing earlier in the spring and bird migration arrival times are changing



Source: Forister, University of Nevada Reno and Shapiro, University of California Davis 2008



Source: PRBO Conservation Science 2008

Evidence suggests that wine grapes are blooming earlier



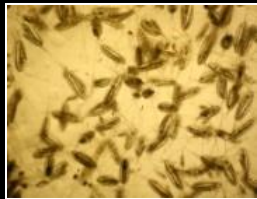
Source: Kim Nichols Cahill, Stanford 2008

Forest vegetation is contracting upslope



Source: James Thorne, University of California Davis 2008

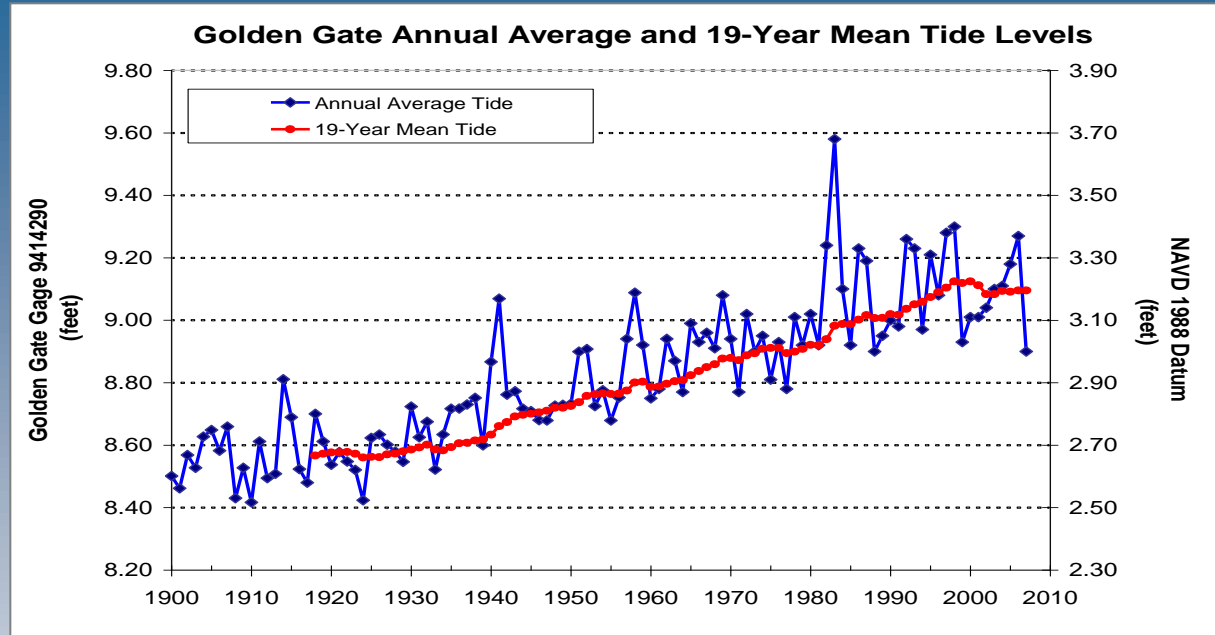
Climate Change: Pacific Ocean and Coast



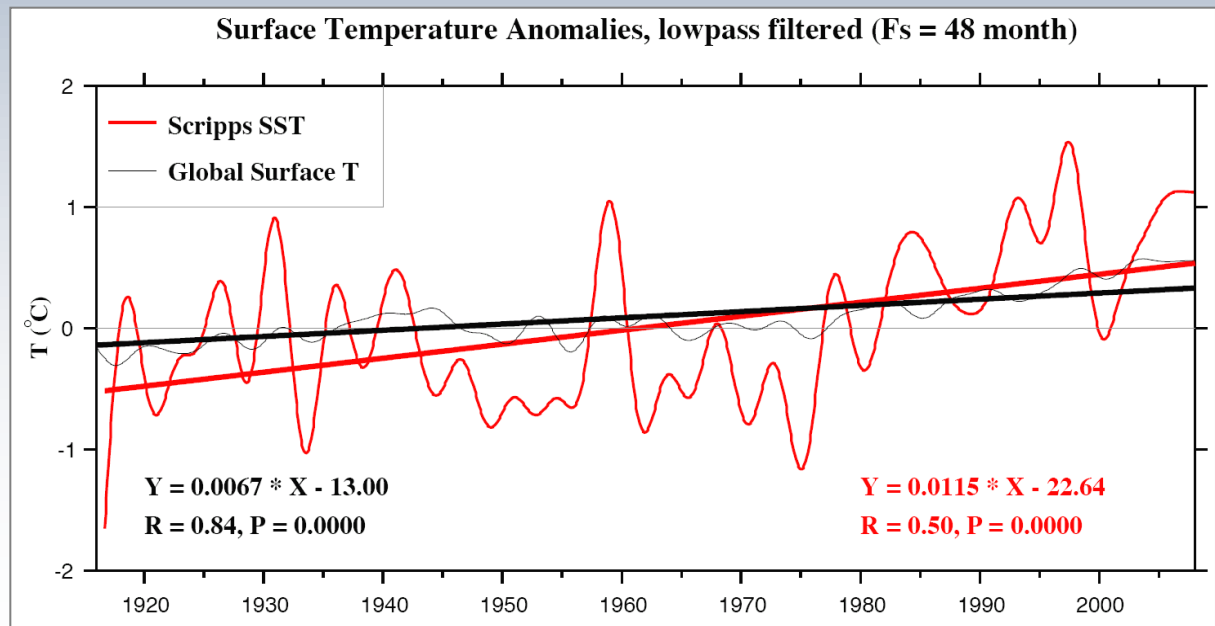
Sea levels and surface temperatures have increased



Source: Maurice Roos, Binta Coleman, Department of Water Resources 2008

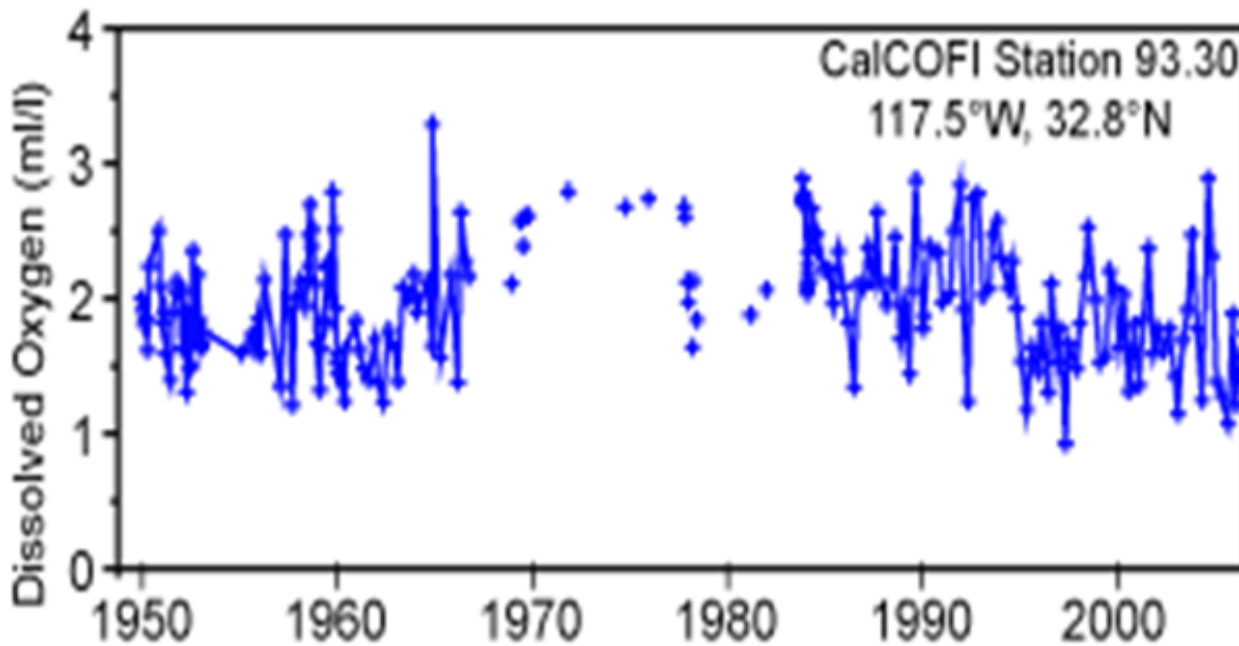


Source: Frank Schwing, National Oceanic and Atmospheric Administration 2008

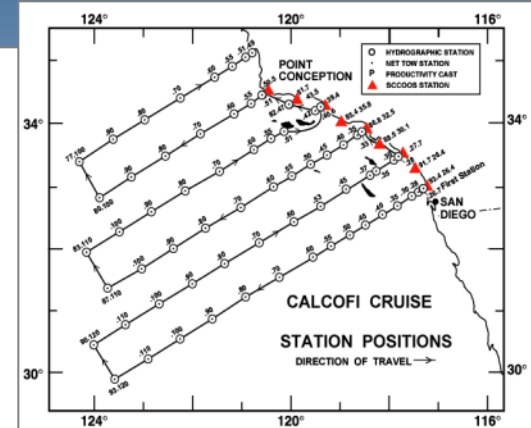


Dissolved oxygen levels in the Southern California Current are declining

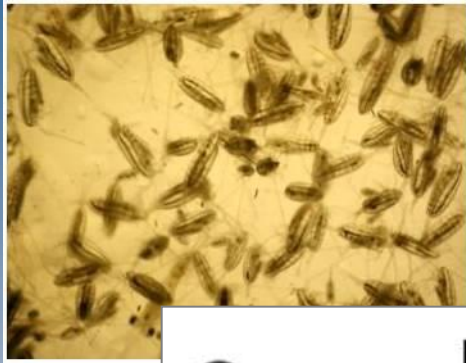
**Dissolved oxygen levels off the coast of San Diego
(at 200 m depth)**



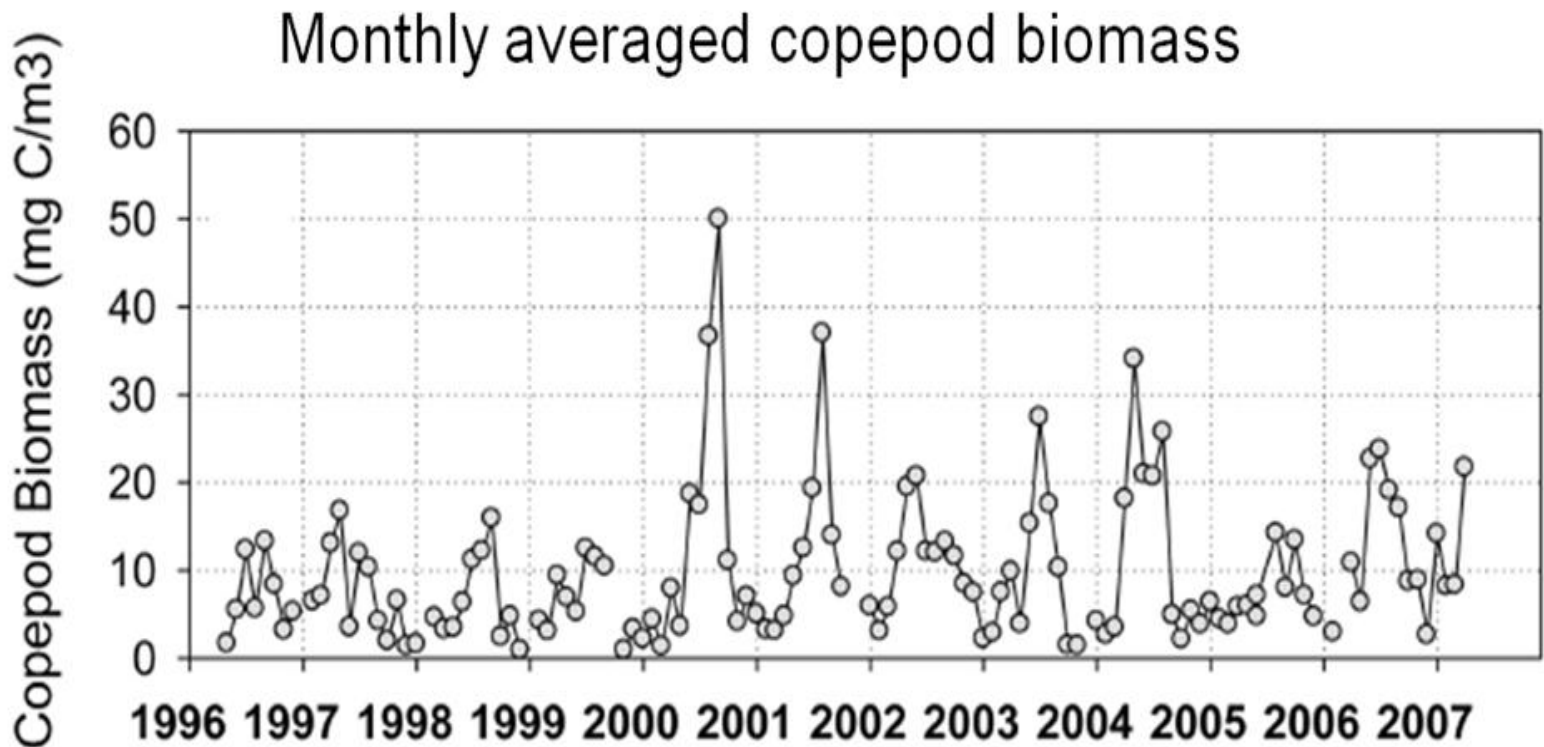
Note: The unconnected points denote a period of limited sampling during 1968 to 1983; the connected points denote regular scheduled surveys.



Copepods populations are changing



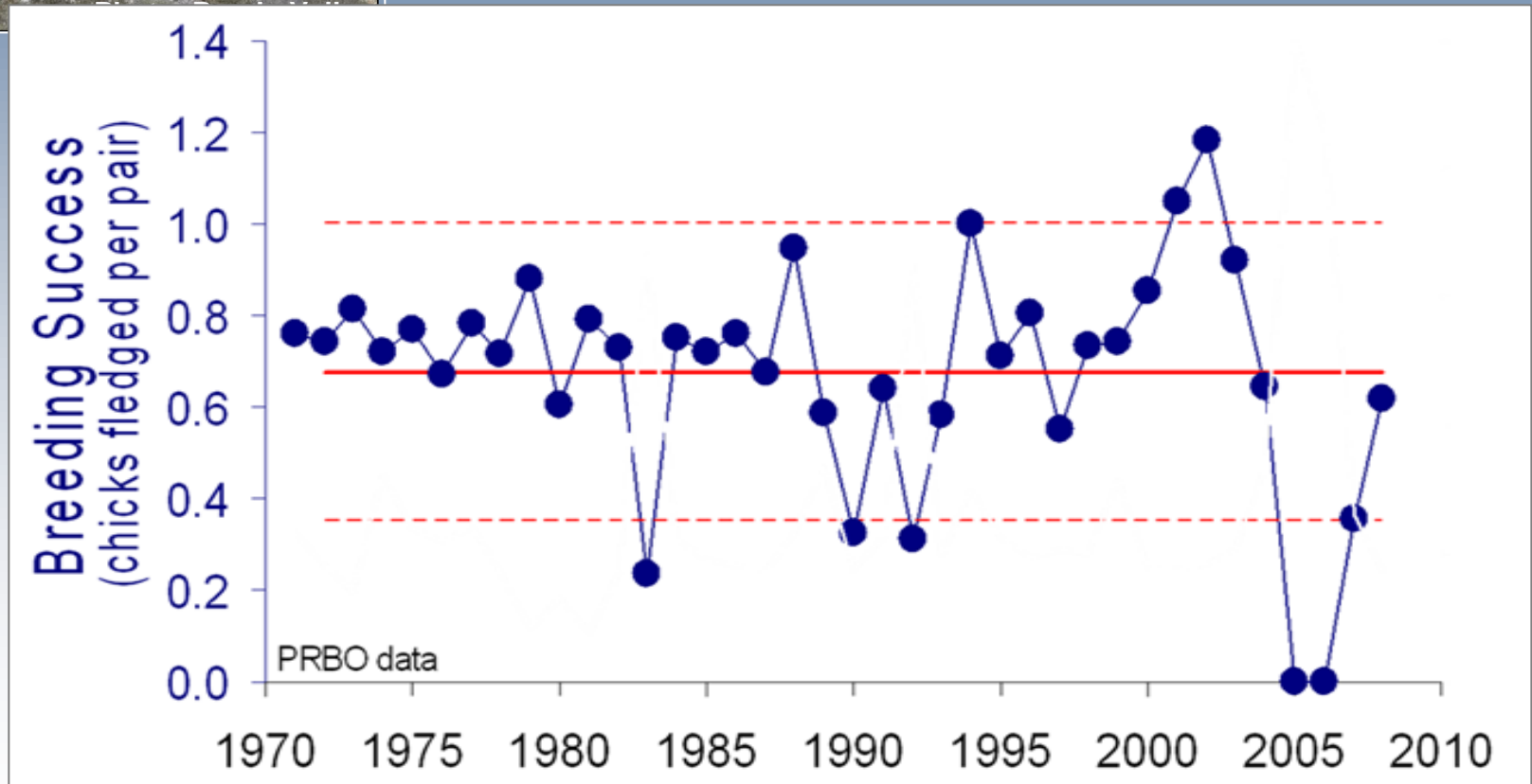
increased variability year to year



Source: William Peterson, National Oceanic and Atmospheric Administration 2008 and Goericke, et al., 2007



Cassin's Auklet breeding success has become more variable



Source: William Sydeman and Jaime Jahncke, based on data from Point Reyes Bird Observatory 2008



Human health impacts are harder to discern

OEHHA has studied heat-related mortality and found an association between ambient temperature and mortality

Source: Rupa Basu and Bart Ostro, Office of Environmental Health Hazard Assessment 2008

Mosquito-borne diseases are under investigation and the results are unclear

Source: William Reisen, University of California Davis 2008

California's Story

Indicators based on observational data reveal climate change impacts in California are consistent with global trends and that.....



Indicator evidence of climate change impacts date back to:



Model T
1908



USEPA
1970



IPCC
1988

Early 1900's

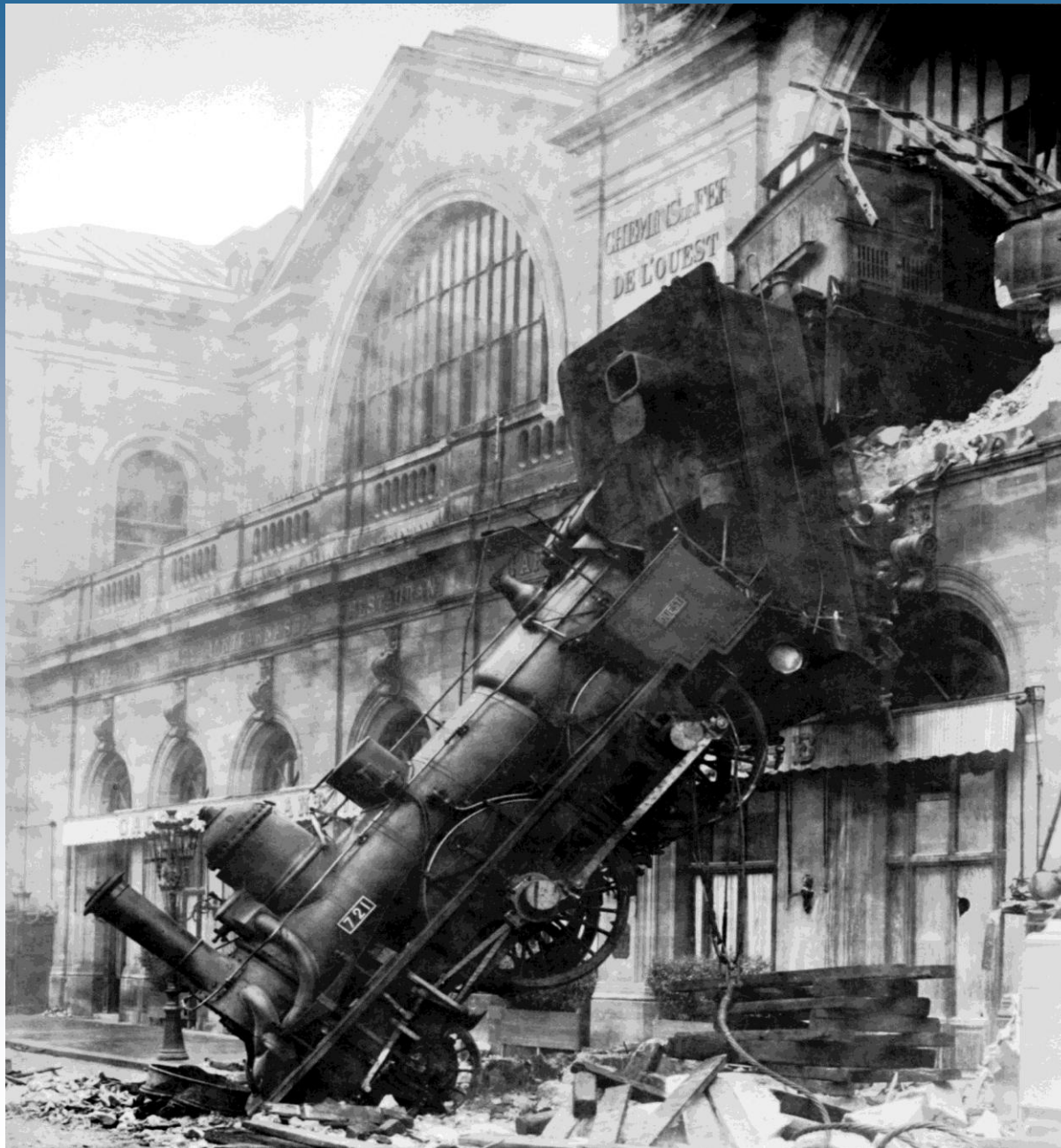
- glaciers
- minimum air temperatures
- sea level rise
- ocean temperature warming
- forest vegetation patterns

Mid 1900's

- snowmelt runoff
- winter chill hours
- extreme heat events
- Lake Tahoe water warming
- butterfly flight

Late 1900's to 2000's

- ocean oxygen concentrations
- tree mortality
- large wildfires
- Cassin's Auklet
- bird migration



Hydroikos Ltd.

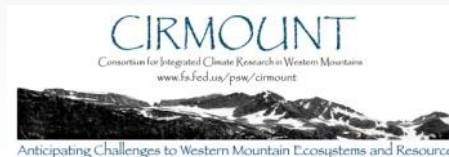
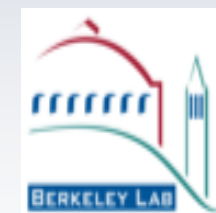


Contributors



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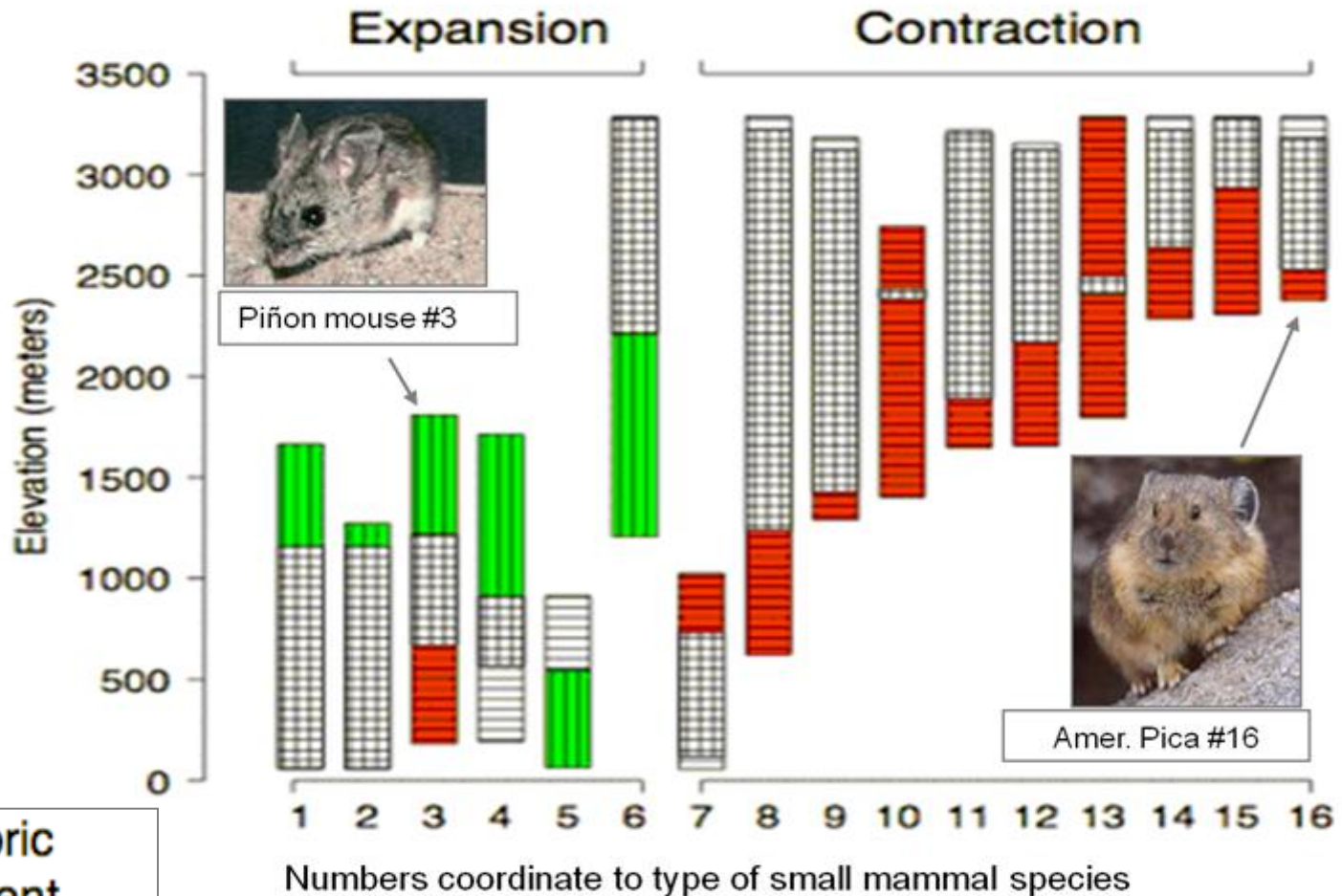
For more information
www.oehha.ca.gov
www.oehha.ca.gov/multimedia/epic/climateindicators.html

lmazur@oehha.ca.gov

Special thanks to: Angela De Palma- Dow,
OEHHA

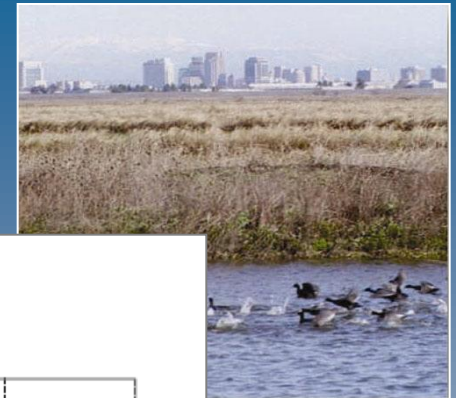
Certain plant and animal species are now found at higher elevations.

Shifts in small mammal elevation range in Yosemite National Park

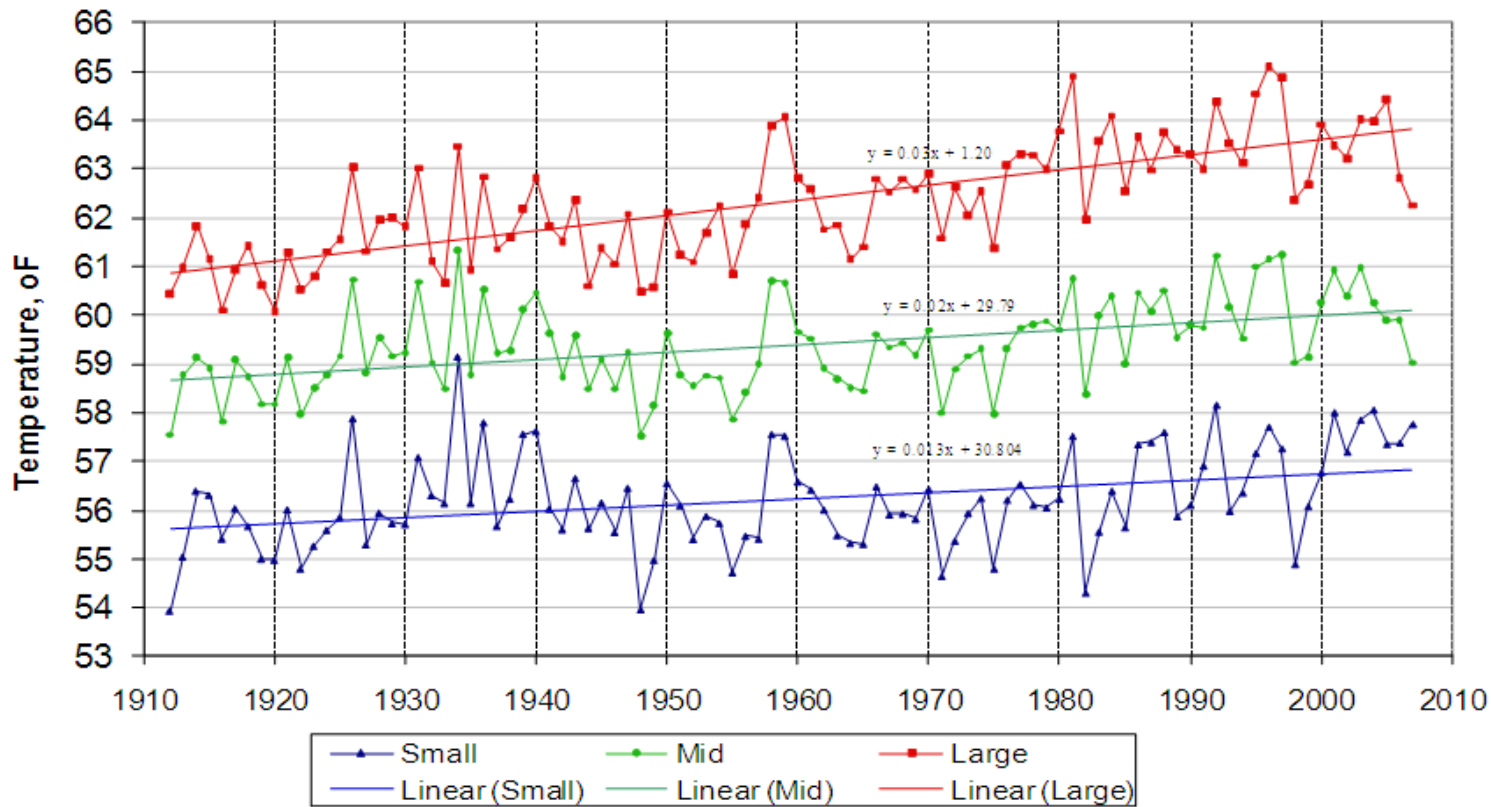


Source: Moritz, University of California Berkeley 2008

Air Temperature by County Population



Average Temperature at 65 California Stations
Stratified by 1990 County Population
Large over 1 Million, Small less than 100,000

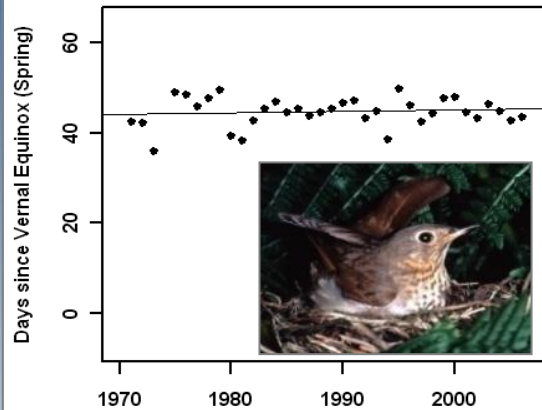


Source: Michael Anderson, DWR, DRI 2008

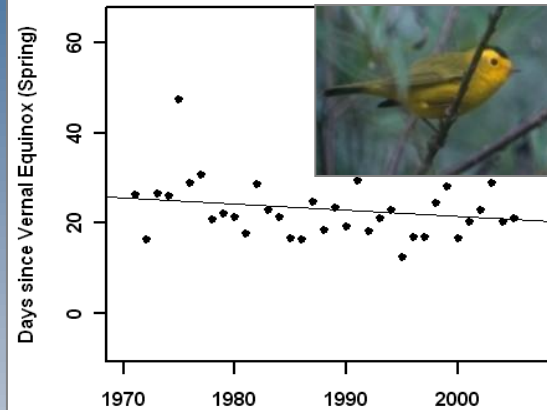
Bird migration arrival times are changing.

Spring arrivals

Swainson's Thrush

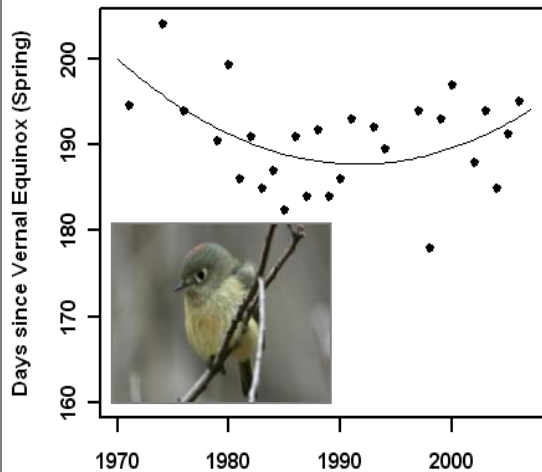


Wilson's Warbler

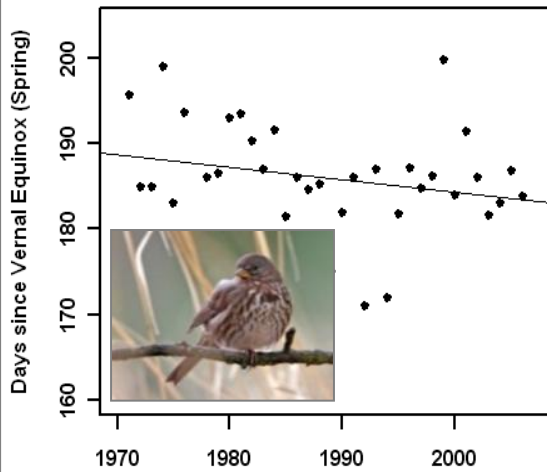


Fall arrivals

Ruby-crowned Kinglet

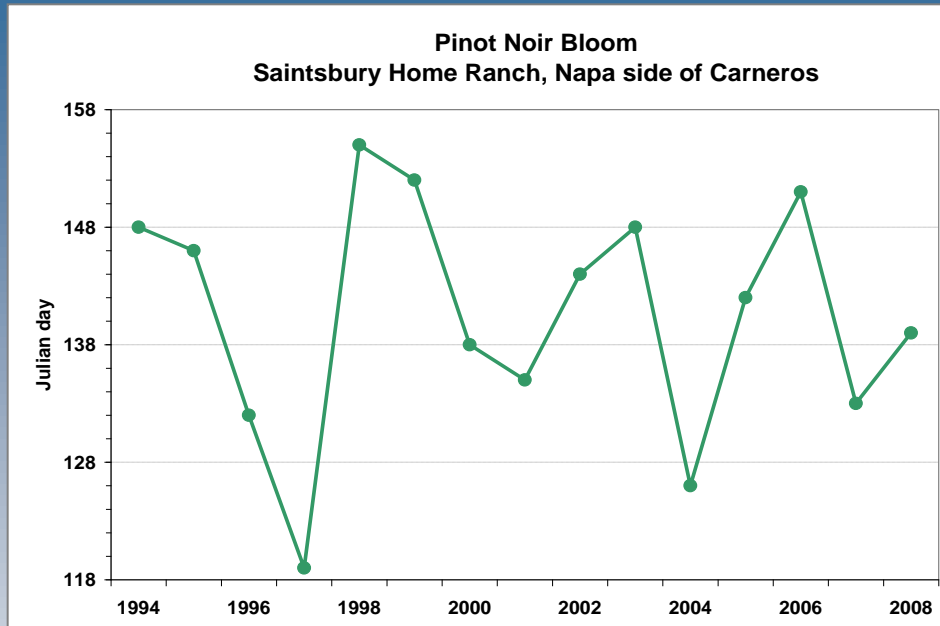


Fox Sparrow



Source: Point
Reyes Bird
Observatory 2008

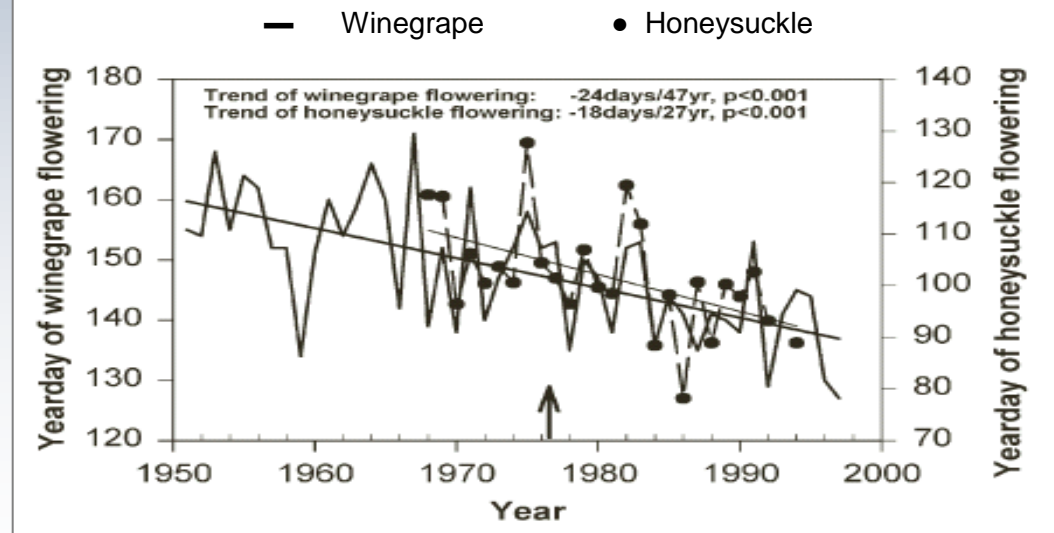
Wine grapes are blooming earlier.



Source: Kim Cahill, Stanford 2008



Estimated wine grape flower dates



Source: Nemani, et al., 2001

Forest vegetation is contracting upslope.

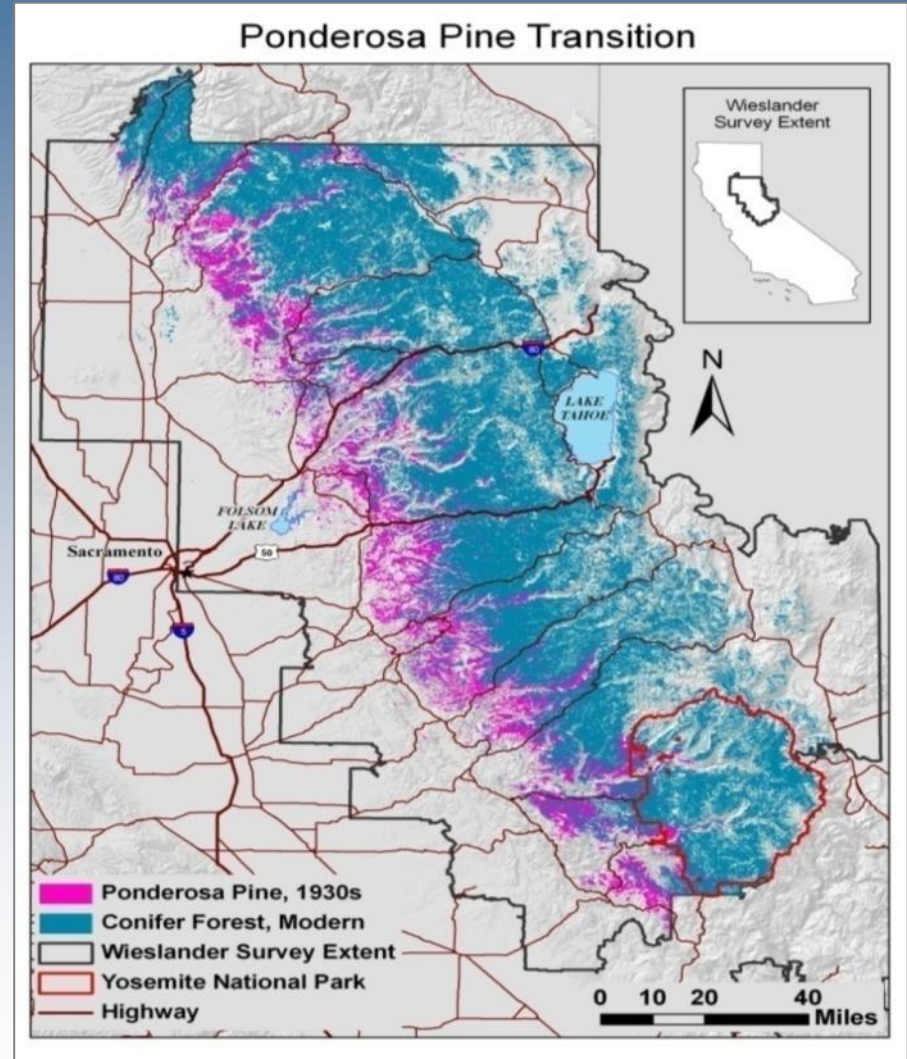
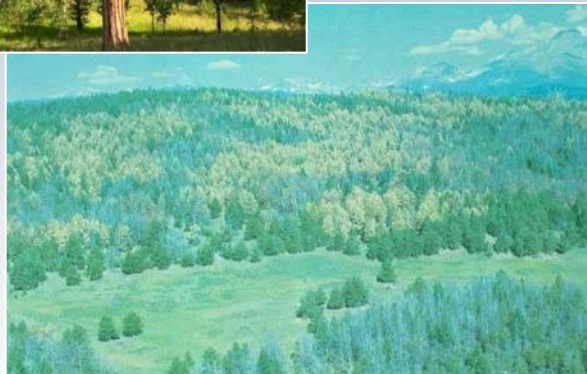


Photo Source: USDA FS NW Region, 1997

Source: James Thorne, University of California Davis 2008